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Assessment of Anadromous Alewife and Blueback Herring Populations in Connecticut Coastal Streams and Connecticut River Tributaries

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Davis, Justin P. and Schultz, Eric T., "Assessment of Anadromous Alewife and Blueback Herring Populations in Connecticut Coastal Streams and Connecticut River Tributaries" (2006). *EEB Articles*. 20.
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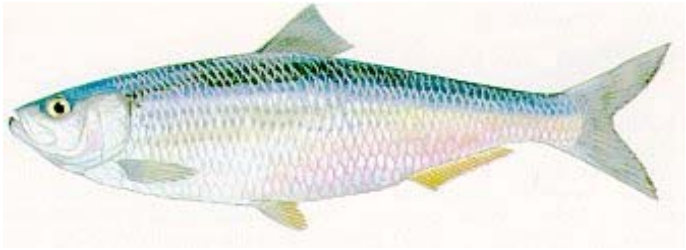

Final Report

Submitted to the Connecticut Department of Environmental Protection

By

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15 December 2005

Executive Summary

Purposes of the Project

Alewife (*Alosa pseudoharengus*) and blueback herring (*A. aestivalis*) occur in anadromous populations that have a largely overlapping distribution from Florida to Newfoundland (Loesch 1987). Anadromous populations of these species are commonly collectively referred to as "river herring". Adults inhabit coastal shelf waters until sexual maturity is reached at age 3-5 (Neves 1981). Sexually mature individuals make spawning migrations, commonly referred to as "runs", into freshwater systems during spring months (Loesch 1987). Spawners can survive and return to spawn in subsequent years (Mullen et al. 1986). Juveniles reside in freshwater for 3-7 months, at which time they undertake a gradual migration to estuarine and marine waters (Loesch 1987).

Many freshwater systems within the State of Connecticut support river herring runs. These fish have historically been taken for use as bait by recreational anglers in Connecticut waters. These species also have ecological significance. Throughout all phases of their life cycle, river herring provide an important source of forage for a wide variety of predators (Loesch 1987). River herring runs can also serve as a vector for nutrient transport from the marine environment to freshwater systems (Durbin et al. 1979). There is also evidence that the seasonal presence of river herring in freshwater systems may benefit sport-fish species (McCaig 1980; Yako et al. 2000).

There is compelling evidence that river herring populations in Connecticut are declining. Annual passage of blueback herring at Holyoke Dam on the Connecticut River has declined three orders of magnitude over the previous 15 years (Savoy and Crecco 2004). Available data from other sites in Connecticut provide strong evidence of declines in the majority of streams surveyed, with the worst declines being noted in large river watersheds (Gephard et al. 2004). In response to these declines, an emergency fishery closure for inland waters was instituted by the Connecticut Department of Environmental Protection (CDEP) in 2001; this closure is still in effect.

The purposes of this project were to assess river herring population structure at study sites within Connecticut, make inter-watershed and temporal comparisons of population structure, and develop quantitative sampling strategies for estimation of river herring run size. Current data on population structure of river herring in Connecticut are largely unavailable. Collection of these data is crucial to the development of management strategies for amelioration of current population declines and will serve as valuable baseline data for future managers. Comparisons of contemporary population structure data to historic data will help to characterize decade-scale temporal shifts in population structure. Inter-watershed comparisons of population structure data may provide insight into processes driving the disproportionately precipitous declines within large river watersheds. Quantitative estimates of abundance are not available for many runs in Connecticut due to the prohibitive amount of cost and effort required to perform a census. Assessment of candidate quantitative sampling strategies will elucidate levels of sampling effort at which reasonably accurate and precise estimates of run size can be obtained.

Objectives:

- Assess abundance, species composition, size structure, age structure, spawning history, growth, and reproductive effort of river herring runs at two Connecticut streams in 2003-04.
- Compare contemporary river herring population structure data to historic data.
- Compare contemporary river herring population structure data from two sites located in different watersheds, one of which was within a large river watershed.
- Use census data obtained from study sites to assess candidate sampling strategies for estimation of river herring run size.

Methods:

- Two study sites were selected: Bride Brook, a small coastal stream in East Lyme, CT and Roaring Brook, a tributary of the Connecticut River located in Hadlyme, CT.
- Weir-style fish traps were constructed and maintained at both sites during the spring migration season (March-May).
- River herring capture at both sites was quantified daily.
- Because recapture, and subsequent over-estimation of run size, was considered highly probable at Roaring Brook, a mark-recapture exercise was conducted to estimate the rate of recapture and correct run-size estimates.
- Random samples (up to 100) of river herring were collected from both sites on a weekly basis for assessment of size structure.
- A portion of the river herring collected during each weekly sample (approximately 50) was taken to the lab for assessment of species, age, spawning history, and reproductive condition.
- Previous studies of river herring population structure in Bride Brook and the Connecticut River (Kissil 1969; Marcy 1969; Kissil 1974) were used for historic comparisons.
- A computer simulation program was developed to test two candidate sampling strategies on a simulated river herring run. These sampling strategies were based on quantification of daily fish passage on a sub-set of days within the run season.

Key Findings:

- Totals of 117,158 and 81,350 river herring were captured at Bride Brook in 2003 and 2004, respectively.
- All river herring collected at Bride Brook during weekly samples were alewives. This finding, coupled with the historic lack of blueback herring at this site (Kissil 1974, S. Gephard, CDEP, personal communication) led to the conclusion that all river herring captured were alewives.
- The run at Bride Brook in 2003 and 2004 was dominated by fish from the 2000 year class that were first-time spawners. The majority of fish in the run were 3-5 years old. Fish older than 5 years were largely absent.
- Comparison of alewife population structure at Bride Brook in 2003-2004 to corresponding data collected in 1966-67 revealed that fish in current runs were

less abundant, younger and smaller, and were more likely to be first-time spawners.

- Totals of 1,675 and 68 river herring were captured at Roaring Brook in 2003 and 2004, respectively. The low run size in 2004 prevented any detailed analysis of population structure.
- Correction for estimated recapture yielded an estimate of 1,614 river herring captured at Roaring Brook in 2003; no correction was possible in 2004 due to low daily capture.
- Both species of river herring were collected at Roaring Brook during weekly samples in 2003. Analysis of species composition of weekly samples yielded an estimated run size of 1,199 alewives and 415 blueback herring at Roaring Brook in 2003.
- The run at Roaring Brook in 2003 was dominated by fish from the 1998 and 1999 year classes, the majority of which were repeat-spawners. Fish older than 5 years were largely absent.
- Comparison of blueback herring population structure at Roaring Brook in 2003 to corresponding data collected in the Connecticut River and Thames River in 1966-67 suggested current runs featured younger fish and more first-time spawners.
- Comparison of alewife population structure at Bride Brook and Roaring Brook in 2003 revealed that the run at Bride Brook featured younger fish, smaller fish, more first-time spawners, and higher levels of individual reproductive allocation (relative gonad size, as a proxy for fecundity).
- Computer simulations demonstrated that a two-stage sequential random sampling approach (Mukhopadhyay et al. 2004) was superior to a traditional random sampling approach as both a direct estimator of run size and an inter-year index of relative abundance. Sequential random sampling provided a high degree of accuracy and precision at reasonable sample sizes (< half the days in the run season).

Conclusions:

- Two years of population structure data were gathered at Bride Brook; one year of data was gathered at Roaring Brook.
- Comparison of current river herring population structure to corresponding data collected approximately 40 years ago revealed significant temporal shifts. These shifts include overall decreased abundance, increased participation by younger and smaller fish, greater proportion of first-time spawners, fewer age classes present, and decreased abundance of older fish (> 5 years old) within spawning runs.
- The runs studied are in a reduced state of viability due to reduced abundance, predominance of younger spawners, and more homogenous age structuring.
- Temporal shifts in river herring population structure may be symptomatic of increased fishing mortality and/or predation. These shifts may also be attributable in some part to normal inter-annual fluctuations in population structure.
- Comparison of river herring population structure at Bride Brook and Roaring Brook suggests that river herring utilizing large river watersheds may exhibit

older age-at-spawning, larger size-at-age, greater iteroparity, and lower reproductive effort.

- Inter-watershed differences in river herring population structure may reflect watershed-level local adaptation, normal inter-annual fluctuation in population structure within sites, or differences in dominant sources of mortality.
- The results of this study point to both the probability of significant temporal changes in river herring population structure and the possibility of local adaptation in river herring populations, but more data is needed to assess the validity and generality of these conclusions.
- Random sequential sampling holds promise as a viable approach to estimation of river herring run size.

Recommendations:

- Maintain the inland fishery closure.
- Gather more information on potential by-catch of river herring in marine commercial fisheries conducted within Connecticut state waters. Gather information on harvest rates (by-catch and catch in directed fisheries) in marine fisheries conducted outside of Connecticut state waters.
- Initiate studies that examine specific hypotheses about causative factors related to decline (e.g. predation, excessive fishing mortality).
- Expand monitoring of river herring population structure. Data obtained at a wider variety of sites over a greater period of time will inform managers of the degree to which the reduced state of viability outlined in this study is a general condition. More extensive study may also provide greater evidence of local adaptation of river herring runs. One possibility is the establishment of a series of index sites within the state to be sampled annually for population structure. A random sequential sampling approach may be useful in this context.
- Initiate studies of river herring population genetics. These studies will provide information about the demographic boundaries of river herring runs and will inform the need to conserve sub-specific genetic diversity.
- Establish recovery goals for river herring runs. These recovery goals should not only define target levels of abundance, but also targets for number of age classes and repeat-spawners.
- Upon re-opening of the inland fishery, efforts should be made to quantify harvest levels. These data will provide needed information on the impact of inland fisheries on river herring runs.

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